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ERONCA MANUFACTURING CORPORATION

MIDDLETON, OHIO

ENGINEERING REPORT NO. 694 (ACN 141) *Index
Ref.*

A: DEVELOPMENT OF HIGH STRENGTH, BRAZED ALUMINUM, HONEYCOMB SANDWICH COMPOSITES
ADAPTABLE FOR BOTH ELEVATED AND CRYOGENIC TEMPERATURE APPLICATIONS

For

Geo. C. Marshall Space Flight Center
N.A.S.A., Huntsville, Alabama

(NASA Contract NASS-3445)

MONTHLY REPORT NO. 1

For
JULY, 1963

PREPARED BY Bruce E. Framer CHECKED BY D. Y. Potter

Bruce E. Framer Aug. 12, 1963 12 P
Project Engineer

Donald Y. Potter
Staff Engineer

COMPLETED August 12, 1963

APPROVED BY C. J. Giemza

SJG
C. J. Giemza, Chief Engr.
Structures & Materials
Research

REVISIONS

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AND EACH

This report describes the work accomplished on brazing high strength aluminum alloys, Contract AD8-544, for the first calendar month of the program, July, 1963.

The report includes the following:

1. An introduction describing in a narrated form the scope of the project.
2. The scope and organization and progress of the literature search.
3. Materials selection and procurement action.
Only heat treatable facing sheets will be investigated. Welded (includes diffusion bonded) cere will be used exclusively.
4. Program planning chart and manpower report.
5. Anticipated work for the month of August, 1963.

PREPARED BY BEK
CHECKED BY DVP
APPROVED BY CJS

AERONCA MANUFACTURING CORPORATION
MIDDLETOWN, OHIOHIGH STRENGTH, BRAZED ALUMINUM,
HONEYCOMB SANDWICH COMPOSITES

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1. INTRODUCTION

Realizing the advantages of brazed honeycomb sandwich structures for applications such as liquid oxygen tankage and space vehicles, NASA, by contract to Aeronca Mfg. Corp., has undertaken the development of processes for brazing high strength aluminum alloys. The requirements of the program, as set forth in NASA-5445, are the following (in abbreviated form):

Materials

1. The sandwich face sheet materials shall be readily available high strength alloys which shall include the 2000, 5000, 6000, and 7000 aluminum alloys series.
2. The core materials shall be from the 5000 and 6000 aluminum series. The honeycomb core structure shall be restricted to the hexagonal core configuration with the thickness confined to the one-half inch to one inch range.
3. Braze materials shall be selected initially from the brazing-aluminum-silicon group with subsequent selections from available experimental aluminum braze alloys.

Experimental

Phase I - The Contractor shall conduct a comprehensive literature survey with the major emphasis on recent works related to brazed honeycomb techniques.

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Phase II - A selection of six of the most promising braze alloys will be subjected to a screening test to determine the best brazing alloys for the specified combinations of face and core materials.

Phase III - The contractor shall select the three most promising braze alloys from the six alloys screened, and develop brazing techniques necessary for manufacture of composite sandwich structures having optimum strength.

The literature survey and planning for the program were begun in July. As part of the planning, a trip was made on July 10 to NASA, Huntsville to discuss the technical approach and materials selection. The Contractor's representative and the NASA Project Engineer mutually agreed upon the facing materials and core types as discussed below.

The technical progress section of this report summarizes the progress of the survey, materials selection, procurement action, and program planning.

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II. TECHNICAL PROCESS

A. Literature Survey

Scope and Organization--The literature survey has been organized to collect all current information on brazing aluminum as well as to survey many sources of information that might lead to related practices: such as, mechanisms of oxidation and self-fluxing alloys.

Information on the related subjects is more difficult to categorize and, without imposing limits, could be searched indefinitely.

To establish limits on related topics, only more recent abstracts were searched, then the references which appeared in these recent documents were reviewed. In many instances that process has not been completed because the documents (located by abstract--then ordered) have not yet been received.

Systematic information searching is straightforward for the present topic. Unfortunately, however, a great majority of abstracts on brazing aluminum are related to dip brazing and flux brazing, with no information yet reviewed on brazing alloy development programs.

The systematic search has been organized to include the following topics:

1. Fluxless brazing of aluminum alloys.
2. Brazing aluminum alloy core-imb cor. sandwich panels.
3. Brazing alloys for aluminum.
4. Soldering alloys for aluminum.

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The systematic search is being conducted through three separate channels:

1. A no-cost state-of-the-art patent search is in progress by the Manufacturers Aircraft Association, Inc., 45 Rockefeller Plaza, New York 20, New York.
2. A sub-contract has been let, for a comprehensive literature survey covering the time period 1-94 to present, to the Technical Information Center, Flight Propulsion Division, General Electric Company, Evendale, Ohio.
3. The writer (Contractor's Project Engineer) has conducted a comprehensive search of the important abstracting documents.

The related subjects search was also conducted by the writer, with portions of that search covered during the systematic searching. The writer's systematic search covered the following abstracting documents:

1. Engineering Index--from first publication, date 1888 through July 1963.
2. ASM Review of Metal Literature--from first publication, date 1944 through December 1962.
3. IRC (formerly ASILIA)--from first publication, date 1953 through June 1963.
4. Technical Abstracts--1941 through 1960.

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A special related search on methods of measuring the thickness of aluminum oxide films and/or removing films is being conducted.

The writer's related search, in addition to the above documents, gave emphasis to the less common aluminum alloys and inspection techniques. Recent issues (1961-1963) of the following periodicals have been included:

1. Journal of Applied Physics
2. Journal of Chemical Physics
3. STAR (NASA Scientific and Technical Aerospace Reports)
4. Welding Journal
5. Metal Progress
6. Transactions Quarterly, ASM

In many instances, there has been duplication which insured better coverage. For example, to combine systematic and related subjects coverage, the writer reviewed all metallurgy abstracts in ASTIA Bi-weekly Publications for the period 1961 to June 1963. Then he travelled to the ASTIA Library, ASD, WPATE and reviewed the ASTIA file from 1953 to 1963 by subject headlines in a card catalog.

Special mention should be made of the ASTIA Library service. Because of the arrangement in the card catalogs, it was possible to review all of the ASTIA abstracts of interest in a very short period of time.

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B. Materials Selection

1. Facing Materials

It was mutually agreed by NASA's and Contractor's Project Engineers that the facing materials to be investigated would include X7005, X7006, 6061, 6951, 2014, and 2024. This differs slightly from the work statement where a 5000 series alloy is requested. Because the higher strength 6000 and 7000 series alloys are available as braze clad materials, and the probability of brazing these materials is excellent, it is thought to be not necessary to investigate the lower strength 5000 series alloys.

2. Core Selection

Type 3-30x $\frac{1}{2}$ and 4-30x $\frac{1}{2}$ will be selected for initial investigation. High strength heat treatable core materials are preferred; however, for immediate availability we will accept non-heat treatable cores. Meanwhile, high strength foil will be procured for subsequent shipment to core manufacturers. It was agreed that welded cores would be used, because welded cores are more nearly square than hexagonal the core will be of a square type rather than the hexagonal as stated in the work statement.

3. Braze Alloys

A tentative selection of six alloys and the reasons for their choice were communicated through a separate letter to the NASA Project Engineer. The list was tentative because the literature search and personal contacts have not been completed. These heat treatable faces will be used; hence the preliminary studies will not be compromised.

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alloys are given by class rather than specific composition at the present time. The classes of alloys follow:

1. AlSi
2. AlLiCu
3. AlSiCuZn
4. AlGe
5. AlAg
6. AlZn

The first three alloys are established brazing alloys for aluminum. The last three are the experimental alloy systems. While they are shown as binary systems, numerous composition adjustments will be investigated to attain suitable solidus temperatures. The experimental alloys are likely to be ternary or quaternary systems.

C. Procurement Action

Experimental lots of the facing alloys and brazing materials will be supplied at no cost by the Aluminum Corporation of America, New Kensington, Pennsylvania. Sample lots of cores with three types of welds have been ordered. These include:

1. Ultrasonically welded core
--Kentucky Metal Products Company
3104 South Preston Street
Louisville 1, Kentucky
2. Resistance welded core (experimental basis, no cost)
--Revan, Inc.
1741 Raymond Avenue
Anaheim, California
3. Diffusion bonded core (not yet confirmed)
Excel Products, Inc.
P. O. Box 177
Navarre De Grace, Maryland

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III. ANALYSIS WORK

The literature search will be concluded during the month of August but complete review of all reprints is not anticipated until the latter part of September. During the week of August 17, a visit will be made to the AICCI Research Laboratories, New Kensington, Pennsylvania.

The cleaning study and methods of measuring aluminum oxide thickness will be initiated. The first experimental heats of brazing alloys will be melted and melting point determinations will be started.

IV. PROGRAM PLANNING CHART AND MANPOWER ESTIMATE

The Program Planning Chart is shown in Table 1. Bars opposite subjects indicate the initiation date and completion date of the sub-projects. Numbers in the bars indicate anticipated manhour expenditures. No differentiation is made between engineer and technician manhours. The ratio is approximately 1:1. Table 2 shows the planned manpower expenditure as a solid line. The broken line indicates actual expenditures.

